



US007132953B2

(12) **United States Patent**
Young et al.

(10) **Patent No.:** **US 7,132,953 B2**
(45) **Date of Patent:** **Nov. 7, 2006**

- (54) **SPRING SENSOR ASSEMBLY FOR A VEHICLE SEAT CUSHION**
- (75) Inventors: **Oliver J. Young**, Grosse Pointe, MI (US); **John F. Nathan**, White Lake Township, MI (US); **Christopher Ricard**, Rochester, MI (US)
- (73) Assignee: **Lear Corporation**, Southfield, MI (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 53 days.

2001/0010424	A1	8/2001	Osmer et al.
2002/0050173	A1	5/2002	Taguchi et al.
2002/0056918	A1	5/2002	Saito
2002/0100670	A1	8/2002	Ambrose
2002/0125051	A1	9/2002	Aoki
2002/0149490	A1	10/2002	Butler et al.
2002/0157474	A1	10/2002	Babala et al.
2002/0180463	A1	12/2002	Basir et al.
2002/0195806	A1	12/2002	Thomas et al.
2003/0000312	A1	1/2003	Ono
2003/0005775	A1	1/2003	Washeleski et al.
2003/0220766	A1*	11/2003	Saunders et al. 702/173

(21) Appl. No.: **10/606,649**

(22) Filed: **Jun. 26, 2003**

FOREIGN PATENT DOCUMENTS

(65) **Prior Publication Data**
US 2004/0263154 A1 Dec. 30, 2004

EP	0 670 239	9/1995
EP	0 728 636	8/1996
WO	98/35861	8/1998
WO	98/41424	9/1998

(51) **Int. Cl.**
G08B 21/00 (2006.01)
G01L 1/00 (2006.01)
G01G 7/00 (2006.01)
B60K 28/00 (2006.01)
G01D 7/00 (2006.01)

* cited by examiner

Primary Examiner—Daniel Wu
Assistant Examiner—Lam Pham
(74) *Attorney, Agent, or Firm*—MacMillan, Sobanski & Todd, LLC

(52) **U.S. Cl.** **340/665**; 340/666; 340/667; 702/41; 702/42; 702/173; 180/273; 73/862.041; 73/862.042; 73/862.623

(58) **Field of Classification Search** 340/665–667; 702/41–42, 173; 280/735; 180/273; 73/862.041, 73/862.623, 862.626

(57) **ABSTRACT**

See application file for complete search history.

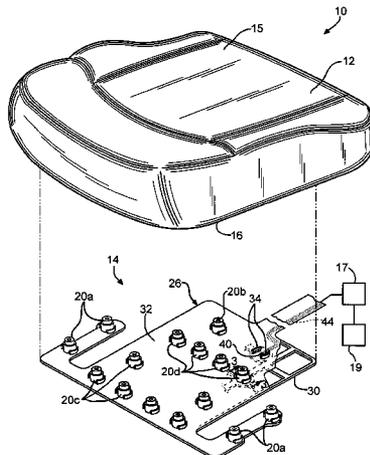
A sensor assembly for use in a vehicle seat cushion for detecting the presence of an occupant includes a first member defining an internal bore. A second member has a portion slidably disposed in the bore of the first member. The first member is movably mounted relative to the first member about an axis. A spring biases the first member relative to the second member. A sensor device is mounted in one of the first and second members.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,738,325	A *	4/1988	Bullivant et al.	177/210	EM
5,284,061	A	2/1994	Seeley et al.		
6,129,168	A *	10/2000	Lotito et al.	180/273	
6,179,378	B1	1/2001	Baumgartner et al.		
6,394,490	B1	5/2002	Osmer et al.		

20 Claims, 3 Drawing Sheets



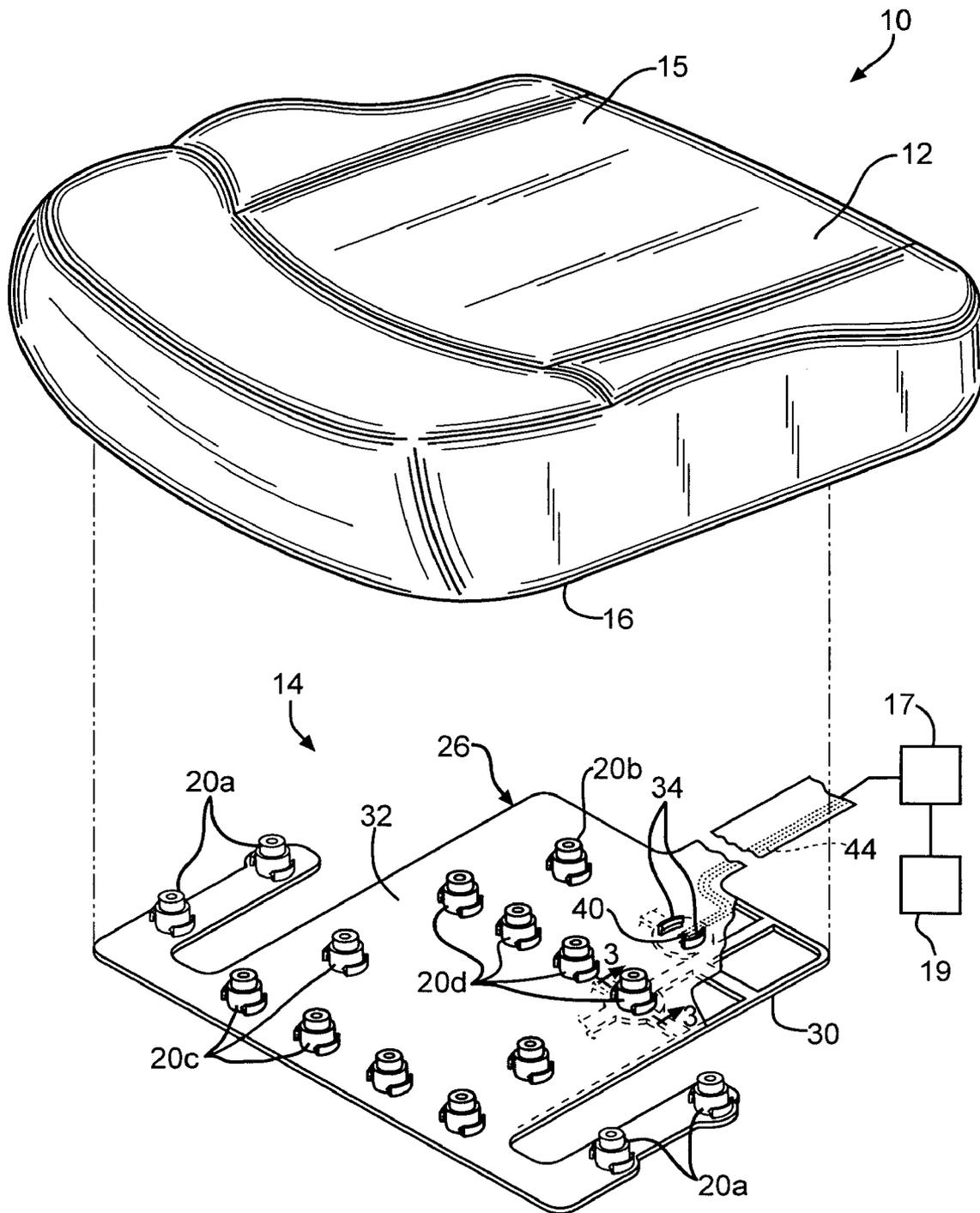
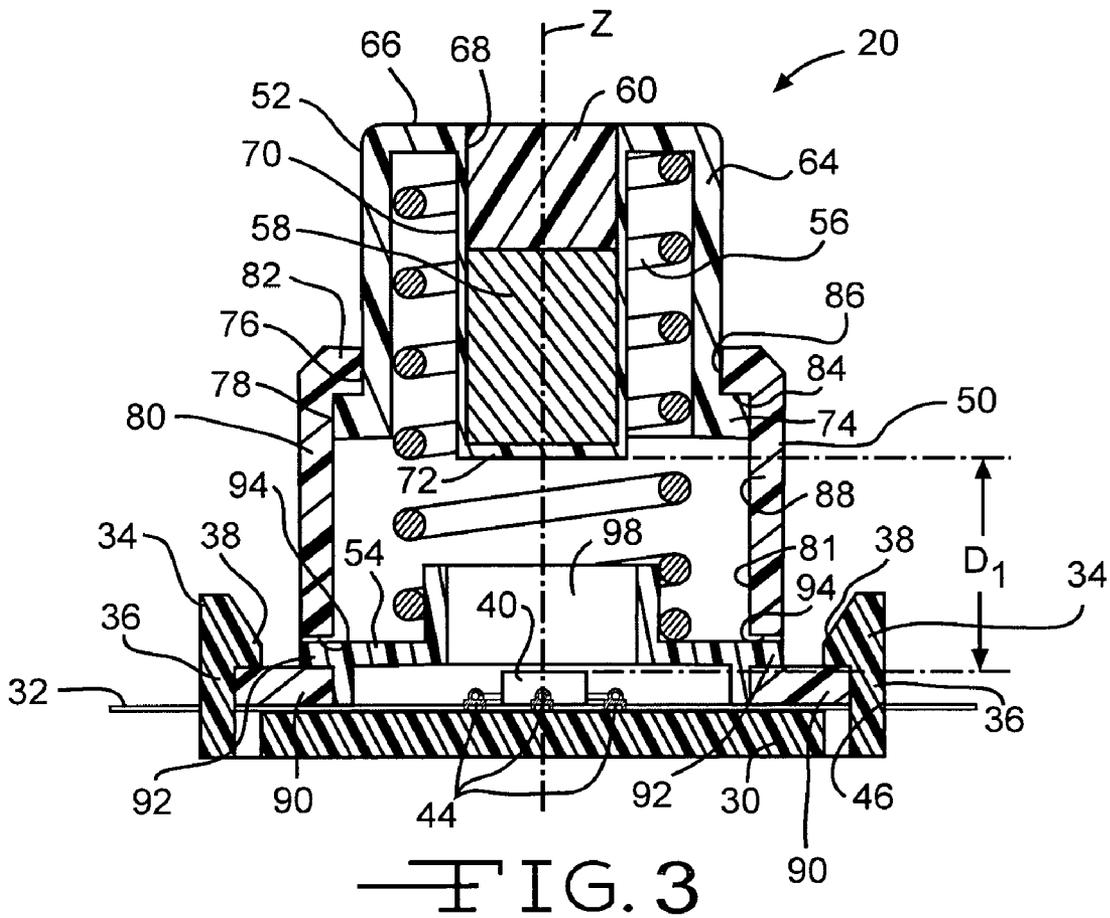
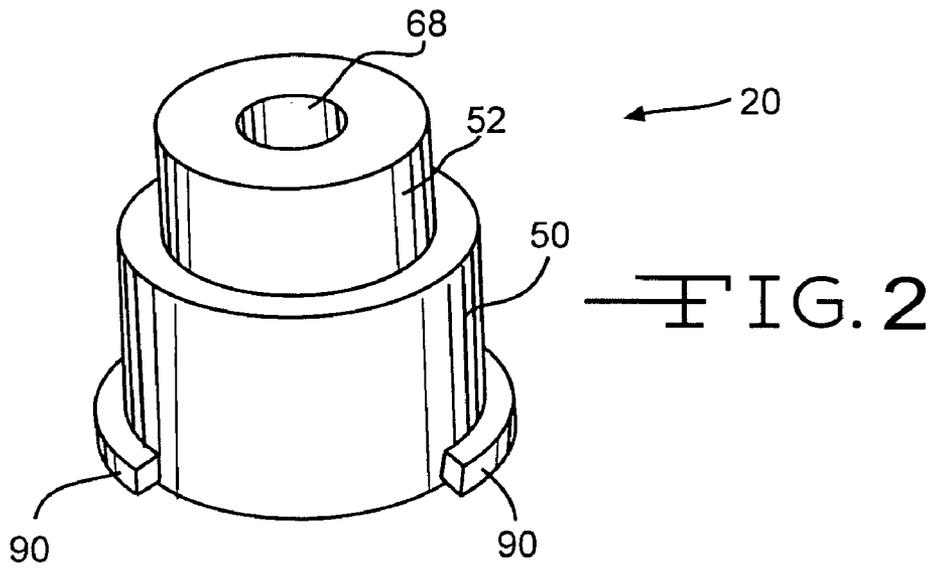


FIG. 1



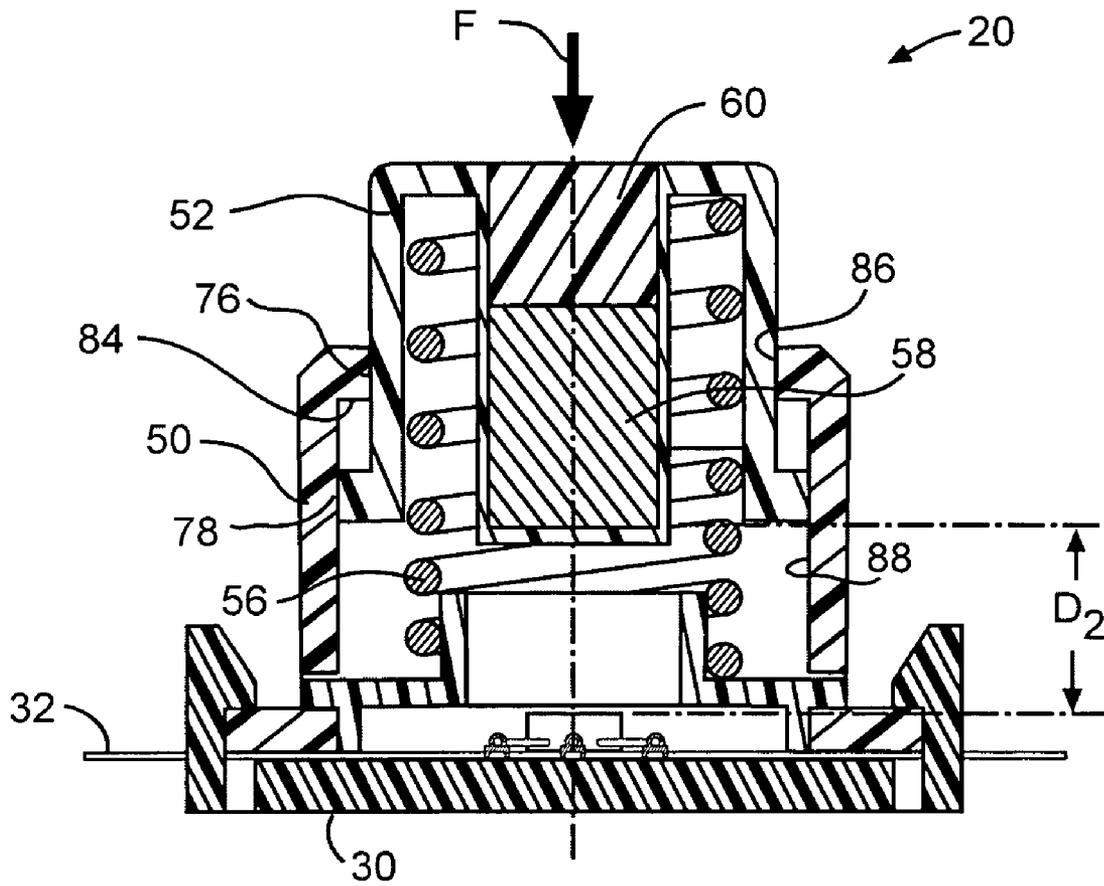


FIG. 4

SPRING SENSOR ASSEMBLY FOR A VEHICLE SEAT CUSHION

BACKGROUND OF THE INVENTION

This invention relates in general to a vehicular seat assembly having a flexible air bag suppression sensor apparatus. More specifically, this invention relates to a spring sensor assembly of the sensor apparatus.

Vehicular air bags play an important role in restraining a seat occupant in vehicular crash situations. However, air bags designed for adequately restraining a large sized occupant may not provide optimal restraint protection for a smaller sized occupant or for a child occupying a child seat. In addition, the deployment of an air bag corresponding to an unoccupied seat represents an unnecessary repair expense.

Sensor apparatuses have been proposed for detecting whether or not a given seat is occupied. These types of sensor apparatuses act as on/off switches in controlling the deployment of a corresponding air bag. However, these types of sensor apparatuses simply address the need for preventing the deployment an air bag when the seat is unoccupied.

Other sensor apparatuses have been proposed to detect the placement of an occupant in a given seat for the purpose of suppressing the deployment of a corresponding air bag. Specifically, these types of sensor apparatuses detect whether or not the front and/or rear portions of a given seat are occupied. In situations in which only the front or only the rear portion of the seat is occupied, a sensor apparatus provides a signal for controlling the degree in which the air bag is to be suppressed during deployment. However, these sensor apparatuses do not provide a means for suppressing the air bag when both the front and rear portions of the seat are occupied.

Other sensor apparatuses have been proposed which determine the weight of an occupant based on detected variations in seat occupancy loading for providing a means of controlling the degree in which a respective air bag is to be suppressed during deployment. However, these types of sensor apparatuses require that a sensor apparatus be directly mounted to the structure of a given seat and that the sensor apparatus itself be structural. Consequently, these sensor apparatuses are relatively massive. Additionally, these sensor apparatuses are typically sensitive to physical and environmental changes that affect the repeatability of the performance of the sensor apparatus.

Other sensor apparatuses include a flexible sensor apparatus mounted to a seating face of a seat cushion. The flexible sensor apparatus includes a plurality of sensors imbedded at various locations of the vehicle seat cushion. These sensors, along with a microprocessor and an appropriate algorithm, are generally capable of detecting both the size of a passenger and the presence of an occupied child seat for the purpose of controlling the degree in which a corresponding air bag is to be suppressed during deployment. The flexible sensor apparatus offers improved reliability, as well as the advantages of being nonstructural and compact. However, the individual sensors are commonly affected by shear forces within the seat cushion, which may lead to false signals. The plurality of sensors are also difficult to install properly onto the sensor apparatus.

BRIEF SUMMARY OF THE INVENTION

This invention relates to a sensor assembly for use in vehicle seat cushions for detecting the presence of an occupant. The sensor assembly includes a first member defining an internal bore. A second member has a portion slidably disposed in the bore of the first member. The first member is movably mounted relative to the first member about an axis. The assembly further includes a spring biasing the first member relative to the second member. A sensor device is mounted in one of the first and second members.

The invention also includes a method of assembling a sensor assembly in which different springs may be used with common housing architecture such that various different sensors can be formed by simply altering the springs of the assembly. A first sensor assembly is provided having first and second members movably mounted relative to one another. One of a plurality of springs is selected having different spring constants. One of a plurality of springs is installed in the sensor assembly, such that the spring biases the first member relative to the second member. A sensor device is installed in one of the first and second members. The sensor assembly is then mounted onto a mat adjacent a hall effect sensor attached to the mat. The mat can then be installed on a vehicle seat cushion. A second sensor assembly can then be created by providing a second sensor assembly including first and second members having the same dimensions as the first and second members of the first sensor assembly. Another one of a plurality of springs is selected having a different spring constant than the spring installed in the first sensor assembly. Instead of installing different springs, the present invention also includes a method assembling a sensor assembly in which different magnets may be used with common housing architecture such that various different sensors can be formed by simply altering the magnets having different gauss characteristics.

Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a vehicle seat cushion assembly including a flexible sensor mat attached to a seat cushion, wherein the flexible mat includes a plurality of sensor assemblies in accordance with the present invention.

FIG. 2 is a perspective view of an embodiment of a sensor assembly for use with the sensor mat of FIG. 1.

FIG. 3 is a cross-sectional view of a portion of the mat and a sensor assembly apparatus taken along lines 3—3 in FIG. 1.

FIG. 4 is a cross-sectional view of the mat and sensor assembly of FIG. 3 wherein the cap of the sensor assembly is shown in a displaced position.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, there is illustrated in FIG. 1 a seat cushion assembly indicated generally at 10. The assembly 10 includes a seat cushion 12 and a sensor mat assembly 14 mounted in the cushion 12. The seat cushion 12 can have any desired contoured shape and is adapted to be mounted on a vehicle seat frame (not shown). As will be explained in detail below, the mat 14 includes a plurality of

sensor assemblies **20** (**20a**, **20b**, **20c**, and **20d**) which detect the presence of an occupant seated on the seat. The sensor assemblies **20** include movably mounted members which detect displacement therebetween caused by the weight of occupant seated on the cushion **12**. The sensor assemblies **20** are electrically connected to a controller **17**, such as a microprocessor. The controller **17** receives sensor input from the sensor assemblies relating to the weight of the occupant caused by the force transmitted through the cushion **12**. Since the mat assembly **14** preferably includes a plurality of sensor assemblies **20**, the sensor input may also determine the position of an occupant relative to the cushion **12**, for example, whether the occupant is seated far forward in the seat. The sensor input may also be used to determine whether a person or an object is seated on the cushion **12**. Based on the reading from the sensor assemblies, the controller **17** controls the operation of a device **19** mounted in the vehicle. The device **19** can be any device which is actuated based on the readings from the sensor assemblies **20**. An example of a device **19** is an air bag module. In this case, the controller **17** determines from the sensor input whether or not to actuate the air bag or to control the deployment force of the air bag. For example, if the sensor assemblies **20** detect the presence of a small adult or child, the controller may stop deployment of the air bag during a detected vehicle impact condition or, alternatively, the controller may actuate the air bag to deploy at a lower force than if a larger adult was detected.

The cushion **12** has an upper seating surface **15**. The seat cushion **12** also includes a lower or downwardly facing surface **16**. The seat cushion **12** can be formed of any suitable layers of material, such as a foam layer and an outer trim material, which permit the transfer of the force from an object resting on the cushion to be transferred to the sensor assemblies **20**. Preferably, the cushion **12** includes grooves or indentations (not shown) formed in the lower surface **16** for receiving the sensor assemblies **20**. Thus, the mat assembly **14** can be simply positioned on the lower surface **16** with the sensor assemblies **20** extending upwardly into recesses of the cushion **12**. It should be understood that the sensor assemblies **20** can be positioned at any suitable position within the cushion **12** which enables forces from the weight of an occupant of the cushion assembly **10** acting on the upper surface of the cushion **12** to be transferred through the cushion and onto the sensor assembly **20**. For example, the mat assembly **14** could be molded into the foam material of the cushion **12**.

Preferably, the mat assembly **14** includes a mat **26** having a lattice type substrate **30** and a covering **32** mounted on and above the substrate **30**. The substrate **30** defines a plurality of mounting locations for the mounting of each sensor assembly **20**. As best shown in FIG. 1 by hidden lines, the mounting locations are located at intersections of the lattice type substrate **30** and include integral mounting features formed therein, such as for example resilient mounting tabs **34**. As will be explained in detail below, the tabs **34** mate with cooperating mounting features of the sensor assemblies **20** to attach the sensor assemblies **20** to the mat **26**. It should be understood that the sensor assemblies **20** can be mounted on the mat **26** by any suitable manner.

The substrate **30** can be made of any suitable material, such as plastic, to provide a generally rigid structure for mounting and positioning the sensor assemblies **20** relative to one another. As best shown in FIG. 3, the mounting tabs **34** of the substrate **30** include a generally vertical portion **36** and a hook portion **38**, the reason for which will be explained in detail below. As shown in FIG. 1, each mount-

ing location includes a pair of tabs **34** for receiving a sensor assembly **20**. In the embodiment of the mat **26** illustrated in FIG. 1, there are sixteen mounting locations. For clarity purposes, one of the mounting locations is shown without a sensor assembly **20** attached thereto. The mounting locations can be formed at any suitable position relative to the other sensor assemblies **20** for providing desired sensor readings or input. For example, it has been found that a pair of sensor assemblies **20a** mounted at each side of the cushion **12** provides adequate sensor input for detection of forces exerted on the side bolster portion of the cushion. The embodiment of the mat assembly **14** also includes a pair of rearwardly positioned sensor assemblies **20b** (one not shown), six frontal sensor assemblies **20c**, and four intermediate sensor assemblies **20d**. Of course, any number of sensor assemblies **20** can be used and positioned at any location on the mat assembly **14**.

The covering **32** can be formed of any suitable material, such as plastic, and may be attached to the substrate **30**. The covering **32** provides for a convenient manner of mounting sensor devices **40**, such as a hall effect sensors, relative to the substrate **30** at each mounting location. As will be explained in detail below, the sensor device **40** cooperates with another sensor device, such as a magnet, movably mounted in the sensor assembly **20** to provide sensor input relating to the displacement of a portion of the sensor assembly which relates to the force exerted on the sensor assembly **20**. The covering **32** can also include electrical wiring **44** either attached thereto or embedded therein for electrically connecting the sensor device **40** to the controller **17**. The covering **32** includes openings **46** formed therein to permit the tabs **34** of the substrate **30** to extend upwardly therethrough.

Referring to FIGS. 2 and 3, the sensor assembly **20** includes a stepped generally cylindrical housing generally having three members: a main body **50**, an upper cap **52**, and a lower closure member **54**. The cap **52** is telescopically slidably disposed in the body **50** about an axis **Z**, generally relating to a vertical axis. For reasons explained below, the sensor assembly **20** further includes a spring **56**, a sensor device, such as a magnet **58**, and an optional plug **60** all disposed within the interior of the housing.

The cap **52** includes an outer cylindrical wall **64** and a circular shaped upper surface **66**. The upper surface **66** includes a central opening **68** formed therein. A generally tubular extension **70** extends downwardly from the upper surface **66** and is in communication with the opening **68**. The tubular extension **70** can be closed off at the lower portion thereof by a circular wall **72**. Alternatively, the circular wall **72** may include an opening formed therein. The cap **52** also includes a lip **74** at the lower portion thereof which extends radially outwardly from the cylindrical wall **64**, the reason for which will be explained below. The cylindrical wall **64** defines a first cylindrical outer surface **76**. The lip **74** defines a second cylindrical outer surface **78** having a diameter which is greater than the diameter of the first outer surface **76**. The magnet **58** is disposed in the tubular extension **70**. If desired, the sensor assembly **20** can include the plug **60** for closing off the opening **68** to help retain the magnet **58** in the tubular extension **70** of the cap **52**.

The main body **50** includes an outer cylindrical wall **80** defining an inner bore **81**. The body **50** also includes a flange **82** extending radially inwardly from the upper portion of the wall **80** to define a shoulder **84**. The flange **82** defines a first inner cylindrical surface **86**. The wall **80** defines a second

5

inner cylindrical surface **88** having a diameter which is greater than the diameter of the first inner cylindrical surface **86**.

The body **50** further includes a pair of outwardly extending flanges **90** which mate with the tabs **34** to mount the sensor assembly **20** to the mat **26**. The sensor assembly **20** can be mounted on the mat **26** by rotating the body **50** until the flanges **90** are captured underneath the hook portion **38** of the tabs **34**. Alternatively, the flanges **90** can be captured underneath the hook portions **38** by a snap fit arrangement in which the body **50** is pressed downwardly over the tabs **34** such that the vertical portions **36** flex to permit the flange **90** to slide downwardly until the hook portion **38** snaps back into position. Of course, the sensor assembly **20** can include any other suitable mounting arrangement.

As shown in FIG. 3, the closure member **54** closes off the bottom portion of the body **50**. The closure member **54** can include outwardly extending ears **92** which are flexibly inserted into apertures **94** formed in the wall **80** of the body **50**, thereby removably attaching the closure member **54** to the body **50**. The closure member **54** also includes an upwardly extending cylindrical tubular extension **98**.

Prior to attachment of the closure member **54**, the spring **56** is inserted into the interior of the body **50** and the cap **52**. The spring **56** biases the cap **52** upwardly relative to the body **50** such that the lip **74** engages with the shoulder **84**. The spring **56** can be any suitable spring structure, such as a coil spring, which biases the cap **52** upwardly relative to the body **50**. This positions the magnet at a predetermined distance D_1 from the hall effect sensor **40** when the sensor assembly **20** is mounted on the mat **26**. The sensor assembly **20** illustrated in FIG. 4 is shown in a "loaded" position, such that a force F acts upon the cap **52** to slidably move the cap **52** into the interior of the body **50** against the return force of the spring **56** such that the magnet **58** is at a distance D_2 from the hall effect sensor **40**. The hall effect sensor **40** detects the displaced position of the magnetic field generated by the magnet **58** relative to the sensor **40**, thereby generating a sensor input signal to the controller **17** corresponding to weight or force F acting on the upper surface **66** of the cap **52**. The sensor input signal is transmitted via the wiring **44** from the hall effect sensor **40**.

One of the advantages of the structure of the sensor assembly **20** is that the cap **52** generally remains in a vertical position along the axis Z during movement of the cap **52** relative to the body **50**. It is undesirable to permit the cap **52** to tilt about the axis Z since this movement could effect the distance between the magnet **58** and the sensor **40**, thereby emitting a false signal. This consistent vertical movement of the cap **52** relative to the body **50** is provided by the sliding arrangement of the surfaces **76**, **78**, **86**, and **88**. These pairs of mating surfaces help prevent the cap **52** from tilting relative to the body **50**. There are often shear forces exerted on the sensor assembly **20** from the foam of the cushion **12**. It is desirable for the sensor assembly **20** to not move the cap **52** relative to the body **50** when subjected to these shear forces to prevent false or misleading readings.

Another advantage of the sensor assembly **20**, is that the interior of the body **50** and the cap **52** define a spring chamber which is sized to accommodate different springs **56** having differing spring constants. It is often desirable to "tune" the mat assembly **14** such that the displacement of the plurality of sensor assemblies **20** do not bottom out or deflect enough to provide proper readings. For example, for the sensor assemblies **20a** at the side bolsters of the cushion **12** and the rear sensor assemblies **20b**, it may be desirable to have a lower spring constant, than for the sensor assemblies

6

20c and **20d**. Thus, a common housing including the same body **50**, cap **52**, and closure **54** may be used to produce sensor assemblies having different signal output characteristics. To accomplish this, a common sensor assembly **20** housing is first provided. Next, one of a plurality of springs is selected having a desired spring constant ideally suited for the position and type of cushion used. The spring **56** is then installed into the housing of the sensor assembly **20**. A sensor device and plug may also be installed. The sensor assembly **20** is then installed on the mat **26** as described above. A second sensor assembly having the same dimensioned body **50**, cap **52**, and closure **54** is then provided for installing a different spring. The second sensor assembly **20** is then mounted at the appropriate mounting location of the mat assembly **14**.

The common housing architecture also permits the selection of different sensor devices **40** to be installed into the sensor assembly **20**, in a similar manner as described above with respect to the spring **56**. For example, a magnet having a desired gauss characteristic can be chosen from a plurality of magnets having differing gauss characteristics.

In accordance with the provisions of the patent statutes, the principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A sensor assembly for use in a vehicle seat cushion for detecting the presence of an occupant, said assembly comprising:

- a first member defining an opening;
- a second member having a portion slidably disposed in said opening such that said second member is movably mounted relative to said first member along a predetermined path;
- a spring housed at least in part in said opening, said spring biasing said first member relative to said second member; and
- a sensor device mounted to detect relative movement between said first and second members.

2. The assembly of claim 1 further including a magnet mounted in one of said first and second members.

3. The assembly of claim 2, wherein said sensor device is a hall effect sensor mounted relative to the other one of said first and second member and at a spaced position relative to said magnet, and wherein movement of said first member relative to said second member causes said hall effect sensor to detect the change in position of said magnet.

4. The assembly of claim 1, wherein said spring biases said first member relative to said second member in a direction parallel to said predetermined path.

5. The assembly of claim 1, wherein said spring is a coil spring.

6. The assembly of claim 1, wherein said first member defines a stepped bore having a first internal diameter portion and a second internal diameter portion having a diameter less than the diameter of said first internal diameter portion, said stepped bore defining a shoulder between said first and second internal diameter portions, and wherein said portion of said second member includes an outwardly radially extending lip which is engageable with said shoulder to function as a stop to prevent movement of said first member relative to said second member.

7. The assembly of claim 6, wherein said second member defines a first external diameter portion slidably disposed adjacent said first internal diameter portion, and wherein

said second member defines a second external diameter portion slidably disposed adjacent said second internal diameter portion.

8. The assembly of claim 6, wherein said spring biases said lip against said shoulder.

9. The assembly of claim 1, wherein one of said first and second members is adapted to be mounted on a sensor mat, and wherein said sensor device is mounted on said sensor mat.

10. The assembly of claim 9 further including a magnet mounted on one of said first and second members, and wherein said sensor device is a hall effect sensor mounted relative to the other one of said first and second member and at a spaced position relative to said magnet such that movement of said first member relative to said second member causes said hall effect sensor to detect the position of said magnet.

11. The assembly of claim 1, wherein said first and second members define a spring chamber sized to accommodate different springs having differing spring constants.

12. The assembly of claim 1, wherein said second member defines an opening, and wherein said spring is housed in said openings of said first and second members.

13. The assembly of claim 1, wherein said opening of said first member is defined by a cylindrical bore.

14. A sensor mat assembly for use in a vehicle seat cushion for detecting the presence of an occupant, said assembly comprising:

- a mat;
- a first sensor assembly mounted at a first predetermined location on said mat, and a second sensor assembly mounted at a second predetermined location on said mat, each of said sensor assemblies including:
 - a first member;
 - a second member movably mounted relative to said first member along a predetermined path; and
 - a spring biasing said first member relative to said second member; and
 - a sensor device to detect relative movement between respective first and second members,

wherein the spring constant of said spring of said first sensor assembly is different from the spring constant of said spring of said second sensor assembly.

15. The assembly of claim 14, wherein each of said sensor assemblies includes a magnet mounted on one of said first and second members.

16. The assembly of claim 14, wherein each of said first members define an opening, and wherein said spring of each of said sensor assemblies is housed at least in part of said opening.

17. The assembly of claim 14, wherein said sensor device of each of said sensor assemblies is a hall effect sensor.

18. A sensor mat assembly for use in a vehicle seat cushion for detecting the presence of an occupant, said assembly comprising:

- a mat;
- a first sensor assembly mounted at a first predetermined location on said mat, and a second sensor assembly mounted at a second predetermined location on said mat, each of said sensor assemblies including:
 - a first member;
 - a second member movably mounted relative to said first member along a predetermined path;
 - a magnet mounted on one of said first and second members; and
 - a sensor device mounted to detect the position of said magnet,
- wherein the gauss characteristic of said magnet of said first sensor assembly is different from the gauss characteristic of said magnet of said second sensor assembly.

19. The assembly of claim 18, wherein each of said sensor assemblies includes a spring biasing said first member relative to said second member.

20. The assembly of claim 19, wherein each of said first members define an opening, and wherein said spring of each of said first and second sensor assemblies is housed at least in part of said opening.

* * * * *